BROOKHAVEN NATIONAL LABORATORY

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WELL KNOWN . . . TO A FEW PEOPLE: ATTRIBUTION OF EXCESS ATMOSPHERIC CO_2 AND RESULTING GLOBAL TEMPERATURE CHANGE TO FOSSIL FUEL AND LAND USE CHANGE EMISSIONS

Stephen E. Schwartz

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Atmospheric Sciences Division/Environmental Sciences Dept.

Brookhaven National Laboratory

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ABSTRACT
The increase in atmospheric CO_2 over its preindustrial (1750) value exceeded 100% of cumulative emissions from fossil fuel combustion (FF, including also cement manufacture) until about 1960, Figure 1. How could this be? Throughout the 19th century and into the early 20th century the major source of incremental atmospheric CO_2 was not FF emissions but emissions from so-called "land-use changes" (LUC), net changes of carbon stocks in the terrestrial biosphere, due mainly to deforestation. LUC CO_2 emissions have been a substantial fraction of anthropogenic CO_2 emissions throughout the industrial period and even at present are about a third as great as FF emissions. Cumulative LUC CO_2 emissions exceeded cumulative FF emissions until about 1965. Because of the long residence time of atmospheric CO_2, the increase in atmospheric CO_2 above preindustrial that can be attributed to LUC likewise exceeded that from FF until about 1965. LUC CO_2 continues to represent about one-third of total excess atmospheric CO_2 and the corresponding forcing; this attribution is robust to the CO_2 impulse profile used but is sensitive to uncertainty in the estimate of LUC CO_2 emissions. These conclusions come as a surprise to many. However, the dominant contribution of LUC to excess CO_2 emissions and atmospheric mixing ratio was recognized in early work by Stuiver (Science, 1978) and Broecker and Peng (Tracers in the Sea, 1982) and unequivocally demonstrated by Keeling et al (AGU Monograph 55, 1989). The shadow of prior emissions of CO_2 is lengthened further by the relaxation time of the physical climate system. However it is the relatively long residence time of excess carbon in the coupled atmosphere-mixed ocean layer system, about 50 years, that is primarily responsible for the persistent influence of prior CO_2 emissions. These findings have implications for understanding the impact on subsequent generations of CO_2 emitted by prior generations and on climate management.

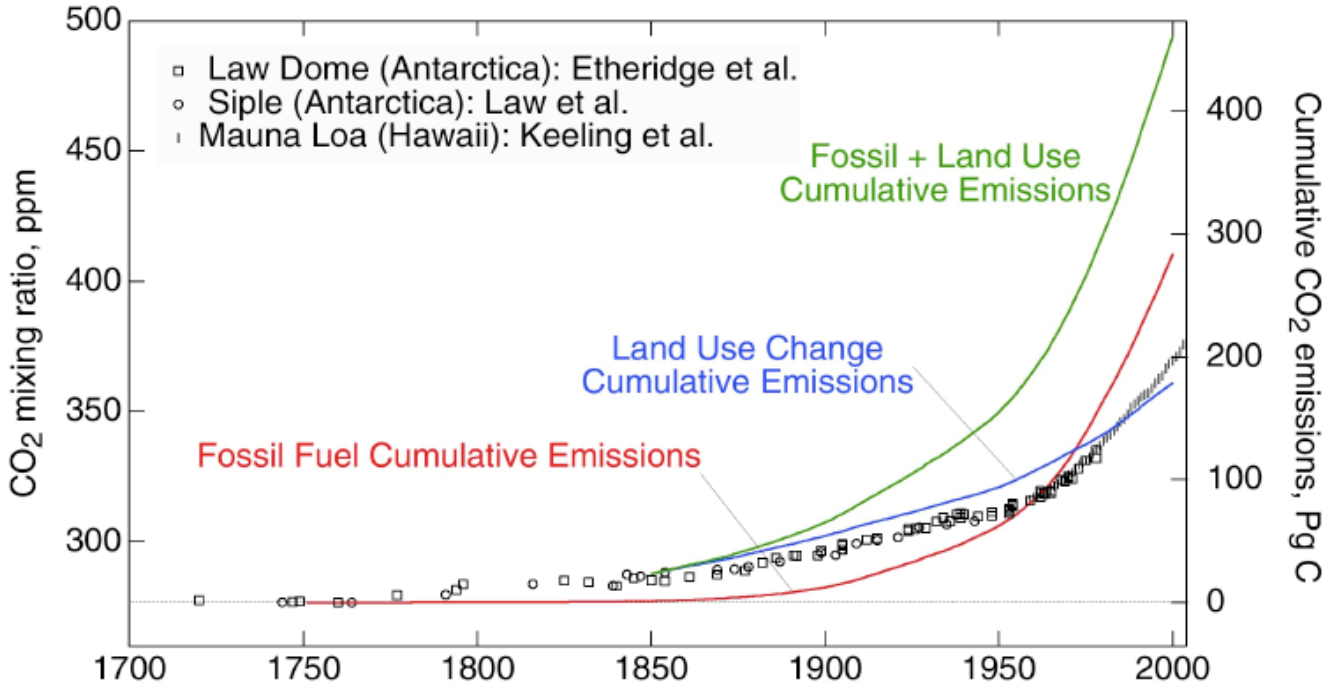

Figure 1. Cumulative CO_2 emissions from land-use changes and fossil fuel combustion (including cement manufacture), and measured mixing ratio of atmospheric CO_2.